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INTERNATIONAL HEALTH EXHIBITION

LECTURES.

PURE MILK.

A Lecture delivered in the Lecture Room of the Exhibition, July 30th, 1884.

BY

G. W. WIGNER, F.I.C., F.C.S.

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A LECTURE ON PURE MILK.

By G. W. WIGNER, F.I.C., F.C.S.

PURE milk is the natural food of infants, and in many cases the most appropriate food for invalids, and it may fairly be said to be essential to the growth of a healthy race of men and women. But it is even more than this: milk may be regarded as a model food, and as a complete food. It is a model food because it is nature's own food, designed for the sustenance of the young of animals, and, as such, it contains and furnishes all the nutritive properties in due proportion required by a growing animal.

It is a complete food, because it contains every element which is necessary for the support of the body and the activity of its functions.

Adults, who are living an active life, do not always require the constituents of food in the exact proportion in which they are present in pure milk, and yet there are few circumstances under which life cannot be sustained on milk, when properly taken, and with due care to ensure its digestion.

The food of man, in fact, of children also, most commonly consists of a compound of at least two or more animal or vegetable substances, the combination of which affords the various elements necessary to meet all the demands of animal life, and there is no other food in use which contains in one article all the essential constituents of food excepting milk.

Milk of course differs slightly, according to the animal from which it is derived ; and this point we shall have again to consider at greater length, but at present we must simply view it as a typically perfect food.

It would be hard to give any food a higher recommendation than this, and yet it is not too much to say that two-thirds of the inhabitants of London, or indeed of England, have any practical knowledge of what pure milk is, and that at least one-half of the remainder only consume it occasionally rather as a luxury than as an article of food.

Now milk is not only a perfect food, but it is the most extensively used food. Some might think, that this post of honour belongs to bread, but really I think it would be the food that, including children with the population, is used more extensively than even bread.

From pretty careful enquiry, it appears that the consumption of milk among the middle classes of London is something like 10 gallons per head per year ; but there are a large proportion of the poor to whom the cost of milk is serious, and there are a large proportion of the rich to whom, I am afraid, milk is less palatable than it should be ; and therefore it would be a very moderate estimate to say that, on the average, $3\frac{1}{2}$ gallons per head per year is consumed by the entire population, or say, $1\frac{1}{2}$ ounces per head per day.

Now London has been rendered somewhat notorious by the outcry about the amount of the Water Rates ; it will perhaps surprise some to hear that the amount of the Milk Bill of London is within about 10 per cent. of the amount of the Water Bill of London, and while the water rates amount to about £1,562,000, the milk rates, if so I may call them, amount to £1,400,000 per year, or about 5s. 10d. per head per annum.

There is a good deal of difference, however, in the actual incidence of the milk rate as distinct from the water rate ; because the poor, who have but little money to spare, are practically untouched by the water rate, their proportion of the landlord's tax being almost too small for consideration, while, on the other hand, they are among the largest

consumers of milk, and, unfortunately, from the very necessity of their purchases being small, say ¼*d.* worths, or ½*d.* worths, they buy from the worst vendors, and, without doubt, succeed in procuring the most heavily adulterated milk.

There are milkmen of various kinds in London, some of them of the highest integrity, from whom unquestionably pure milk can be procured at any time, and at a fair price; but it would be absurd to shut our eyes to the fact, that there are in London hundreds and even thousands of men, whose sole qualification for the trade consists in their ability to undersell their neighbours by watering their milk.

Milk consumers have, however, become so habituated to use the poor watered and skimmed milk which is supplied by these tradesmen, that the loss which they incur from day to day is not appreciated; and although their infants are deprived of the food which they require, the result shows rather an increase in the bills of mortality than an improvement in the character of the milk supply.

There is probably no more curious illustration in the whole of our English commerce of the way in which a trade may go on increasing with the increase of the population, or even at a greater rate than the increase, than the milk trade; and yet, despite of this increase, it bears a bad name, so much so, that the finger of scorn is pointed at it. From our earliest boyhood "Simpson" has been a common by-word, and comparatively few children of ten years old fail to understand what are commonly called the milkman's tricks. And yet, though the chalk-and-water talk of some twenty-five years ago, and the sheep's brains even longer since, are exploded fallacies, the bald fact remains, that milk is more adulterated than any other article that is sold in England; and the number of samples of adulterated milk, purchased by the inspectors under the Adulteration Act, are almost or quite as numerous as the adulterated samples of every other kind of food put together.

Of course milk has been a source of an immense number of cases of prosecution and litigation—persecution the milk

dealers call it;—but anyhow, whether it is persecution or prosecution, for close upon twenty-four years—that is, ever since the passing of the Act of 1860 for the suppression of adulteration—milk dealers have appeared in police courts, quarter sessions, and every other court having power to deal with such matters, not only from week to week and day by day, but many times a day, and yet milk adulteration goes on as fast as ever.

I shall have to refer to this subject in detail, with statistics, later on in the course of my lecture, so that for the present I want to point out simply, that there is a bright side to the dark picture I have drawn. I am not quite sure that it is possible to procure genuine milk regularly at the lowest price at which milk is retailed, say at fourpence per quart—exceptional cases may occur, say, for instance, when a public analyst is supplied,—but it is evident from practical experience that those milkmen who are not afraid to charge a price which leaves them a proper margin of profit can and do supply a genuine article; and I venture to say that by doing so, they satisfy their customers far better than if the price were reduced and the quality let down likewise. And considering the subject of pure milk, it is essential that I should first of all look at its constituents, and to some extent consider their food value separately and collectively.

Pure milk ought to be such a simple and straightforward term that it should not need definition, but legal sophistry has been exerted to such an extent upon the milk subject, and discussions of every sort have taken place in reference to milk, that even these two words differ in meaning according to the views of the persons by whom they are used. I define pure milk to be the milk produced by a properly fed cow in a state of health. I do not by this mean to imply for a moment that a cow should be fed to the highest pitch which modern science can devise, or that a veterinary surgeon should be kept in constant attendance upon it; but I do imply, that a man who puts forward his herd of cows as milk-producing machines, and sells the

milk which these cows produce to the public as genuine milk, is bound to take reasonable precautions to keep them in health, and such proper precautions as any man who values his stock would take, to see that they are sufficiently fed with proper food to prevent their deterioration in health and milk-giving power.

There are certain persons in the milk trade who distinctly challenge this view, and I shall not be putting the matter fairly before you if I do not state their arguments from their point of view, even though I state them merely to show their fallacy. The view which these representatives of a certain section of the milk trade take is, that any liquid which comes from the udder of a cow—no matter how much that cow may have been wrongly fed—is pure milk, and has a right to be classed as such, and to be exempt of the penalties of the adulteration Act. The leading argument which they put forward in favour of this view is, that the prize beasts of the agricultural shows have frequently given milk below the usually accepted standard of quality both as regards cream and solids not fat. I admit this fact without hesitation; it is well known, but the reason is not far to seek: animals at these shows are fed in such a way as to force the quantity of milk which they yield to the maximum, while at the same time the animals themselves are kept as far as possible in the highest external condition, and calculated to attract the eyes of those who judge of animals by external appearance.

When these very same cows are taken back to their homesteads, regularly and properly fed, kept from the impure air of the show-shed or show-yard, and milked in a proper way, no such abnormal results are obtained, but the milk assumes the ordinary typical character, even when the quantity yielded is somewhat less.

This argument is what I may fairly call the legitimate one, although I have shown its fallacy; but in addition to this, there is used what I call the illegitimate argument, namely, that certain cows, improperly and imperfectly fed, in fact half-starved, have at certain times given milk below

the standard. The most notorious case of this kind is the old case of the cows at the Royal Agricultural College, Cirencester, which Dr. Voelcker admits were half starved, and I certainly cannot admit that milk produced by such animals as this has any right whatever to be classed in the category of pure milk.

Setting aside these two leading arguments against the standard set up, there is very little indeed to say against my argument, that pure milk should not merely be the produce of the cow, but should be the produce of the cow in a healthy condition and reasonably well fed. Granting, then, that this definition be accepted, in the first instance, we have to consider whether it is capable of being formulated in a more distinct way, so that, for instance, it would be possible for the milkman or analyst, by examining the milk, to say whether the liquid fulfils the conditions I have laid down; and here I am compelled at once to say No, it would not be possible; but the utmost that could be done by science and practical knowledge combined is that a certain limit may be laid down below which pure milk will not fall unless under circumstances of a most exceptional character. This limit is in practical use, and is adopted by a very large number of public analysts throughout the kingdom.

I pass now to consider the different constituents of milk, that is the various different parts into which it can be approximately divided, and into some of which, as a matter of fact, it is divided in the various processes of cream, butter, curd, and cheese making. These different constituents are Water, Fat, Caseine, Albumen, Sugar, and Salts, &c.; and for convenience of demonstrating the fact clearly, I have arranged on the table before me a series of bottles (which Messrs. Welford and Sons, who have the large Dairy in the Southern Gallery, have kindly placed at my disposal), that you may see the proportions of each of these ingredients contained in one gallon of milk. Here, for instance, we have the Water contained in one gallon of milk, which amounts to 8lbs. 7oz., and each of the other constituents in

its proper relative proportion. I ought at once to disabuse your minds of the idea that milk is absolutely constant in composition; it varies to some considerable extent, but in talking of it to-day, for popular purposes, I shall assume a fair average composition, and explain the extent to which the variations occur afterwards.

Fat is the most variable and probably the most important of the ingredients of milk. It certainly is the most important from a dairy farmer's point of view, because if the milk contains but little fat, he can procure but a smal proportion of cream and make but little butter from it. From a dietetic point of view also, it is, I say, the most important, or most important but one, of milk constituents. The butter fat is a peculiar one, differing in many respects from all the vegetable fats with which we are acquainted, and differing also to a considerable extent from other animal fats. The most marked point of difference is in the fact that butter contains three volatile fatty acids, the principal one of which is Butyric, which, as far as we know, is not met with in any other fat, either animal or vegetable.

It by no means follows, however, that because butter fat possesses these peculiarities it is easy to identify it; on the contrary, it is only by a tedious and somewhat difficult process of chemical analysis, that the butyric acid can be so far separated as to enable a definite statement to be made as to the purity, or otherwise, of the sample of so-called butter fat.

Commercially we get this fat in a state of what may be called "*semi-purity*," as Cream. Good cream contains from 50 to 60 or 65 per cent. of butter fat, the remainder consisting of water and a small proportion of the other constituents of milk. When cream is churned into butter the envelopes of the fat globules are broken, and a large number of these tiny little spheres of fat, originally of microscopic size, adhere together, while a large proportion of the water and the soluble constituents are washed away with the butter milk. We thus get butter fat in a still higher state of purity.

Good butter, well made and well worked, should contain somewhere about 88 per cent. of pure butter fat, and the highest class of butters will contain rather more than this. To get the butter fat, however, in a state of purity, the butter must be melted with the water, soluble matters and curd separated; the clear limpid oil of beautiful amber-colour floats on the top. This, when poured off and allowed to chill, forms pure butter fat.

Fat in some form or other is an absolute essential to the dietary. If children are brought up without the use of butter, or a butter substitute, they rapidly lose health and condition, and even in many savage races, we find that the fat of animals is consumed in large quantities, taking the place of the butter of more civilised countries. Following out this argument, I see no reason why, with proper precautions in its manufacture, butterine should not be used to a considerable extent, to replace the deficiency of butter from which we at the present time suffer. Butterine, when properly made, is nothing but the best and purest dripping, flavoured with milk, so as to make it resemble butter as much as possible.

Yet, despite the value of the fat, skim milk, from which the fat has been removed, is a valuable diet, and when properly used, under medical advice, there is no doubt that in many cases of illness it would be more serviceable than even new milk. Unfortunately, however, the ease with which the fat can be removed, offers a considerable temptation to skimming.

The next constituent of milk that we have to notice is Caseine. This is the flesh-forming constituent of milk, and is called curd. It is classed as one of the most valuable constituents, and is a highly nitrogenous matter. Indeed, with the exception of a small amount of albumen and Lacto Protein, all the nitrogen of milk exists in the form of caseine. Caseine forms the basis of our cheeses of every kind, except the real cream cheese. It will therefore scarcely surprise you to hear that it is highly nutritious. We all know how hardworking men live, to a very great

extent, upon cheese with a quantity of bread, and not only do they thrive on the food, but perform an amount of physical work which most of us in this room would be quite incapable of undertaking. It is therefore fair to look upon caseine as being the work-sustaining portion of milk, and to say that if a sample of milk is deficient in caseine, it is deficient in a constituent most necessary for securing health.

Albumen constitutes nearly the whole of the remainder of the nitrogenous matter in milk. It is difficult to define the exact position which this albumen holds in the dietetic value of milk. It forms a small proportion, only about one quarter, of the nitrogenous matter present, but owing to its more soluble form, and the greater difficulty with which it is coagulated, it appears to me extremely probable that its real food value may be higher than the other nitrogenous constituents. There is some amount of evidence, although not yet a certainty, that this form of albumen is peculiar to milk, and that it differs from the albumen present in eggs, but it seems probable, that like the volatile acids present in the fat of milk, this substance has a special nutritive value of its own, and that without this albumen milk would not be a perfect or complete food.

Of course in the case of whey, which is not unfrequently used as a diet, the albumen forms a very important part, because the caseine, containing some three-fourths of the nitrogenous matter, has already been separated, and the albumen, with a trace of Lacto-Protein, form the only nitrogenous matter available.

Sugar of milk is a very peculiar sugar, differing from most other sugars. Nearly all its properties, both chemical and physical, differ from cane sugar, in not being so sweetening in its properties, and yet it has a pleasant taste, perhaps more agreeable in flavour than most of the glucoses and other uncrystallizable sugars. Sugar of milk itself, however, is crystallizable, but with a different form of crystallization to cane sugar or beet sugar, and its solution in water behaves differently during concentration,

a large proportion of the milk sugar present being deposited at a certain stage of the boiling, in an imperfect crystalline form, while the other part remains in solution. The polarization differs considerably from the polarization of any other known sugar. All these different points mark it out as a peculiar sugar. There is a good deal yet to be done in investigating the chemistry of sugar of milk, and it appears very probable that at some future time, further investigation may show that in reality what we look upon as a simple sugar, consists of different substances mixed together in proportions which are at present unknown. Sugar of milk is important in another way, as it forms the great point of difference between human milk and cow's milk.

Human milk contains a larger proportion of sugar than cow's milk, and less fat, caseine, albumen, and ash. It is from this that the formula generally adopted in the manufacture of artificial human milk is obtained; cow's milk is diluted with water, and then milk sugar added; by this means we obtain a liquid which assimilates somewhat closely in chemical composition to true human milk.

Mineral Matter.

This term includes a variety of salts which, physiologically considered, are of very great importance in the composition of milk. It is absolutely essential for the formation of bone and muscle that a growing child, or for the matter of that an adult, should be supplied with certain phosphatic substances, lime salts, etc. Milk contains these ingredients in the right proportions to form the bone and muscle of a child.

We now come to the water, the last and largest constituent.

Water, of course, strictly speaking has no real dietetic value, and yet without water milk itself would be useless as food, because it is essential that the valuable food ingredients of which we have already been speaking should be dissolved or emulsified, so as to be in a suitable form

capable of easy digestion, in fact so that the stomach can easily assimilate them. This water is the bone of contention between public analysts and milkmen, and nothing was more common three or four years ago than to hear a long cross-examination directed solely to the elucidation of the very knotty point—as to whether there was any difference between the water natural to milk, which in fact the cow put into it, and the water which the milkman added.

I should like to consider next, by the aid of a set of samples which have been lent me by the Aylesbury Dairy Company, the mode in which the milk is divided by the dairymen into the different articles of commerce which are most frequently made from it. The samples to some extent speak for themselves, and certainly as regards the first series, that of whole milk, I need not detain you any longer, except to say that here we have fat, caseine, and sugar, all shown in the same form as in the larger bottles on the table. Our next two series of samples here show us the division of the whole milk into cream and skim milk. Cream, as I took occasion to tell you some time ago, does not consist entirely of butter fat, but contains fifty to sixty-five per cent., more or less, according to its quality. And in this series of samples we have the cream divided into the constituents present in a good ordinary commercial sample, and you will see that some thirty per cent. of water is still present, and that this water carries with it caseine, albumen, and salts. We may in fact put it another way, and say that, separate any particular constituent of the milk as carefully as possible by mechanical means, and we always find that some small proportion of the other constituents are present; thus, referring to skim milk: in the first separation we find that it still contains some fat; the amount in skim milk is extremely variable, according to the mode of manufacture. The Centrifugal machine, which you can see at work in the south gallery, is by far the most efficient and most successful for separating the cream from the milk.

The principle of the centrifugal separator is practically

identical with the principle of skimming, although the two processes appear so dissimilar. The milk revolving in the separator at great speed acquires immensely increased centrifugal force, which corresponds to the force of gravity. This centrifugal force acts more strongly on the heavy non-fatty portion of the milk and less strongly on the cream, and consequently the non-fatty part of the skim milk gravitates by the centrifugal force to the outside of the revolving circle, leaving the cream to flow away in the inside in an almost pure condition.

A few weeks ago I tried experiments with each of the separators at work in these dairies, and in some cases found the proportion of fat present in the skim milk reduced to even less than ·1 per cent.

These separators at the same time produced cream of high quality, and the skim that they produced is more palatable than skim milk obtained by the old process. I have known this statement to raise a smile on the faces of those who thought they knew all about milk, and have wondered how it was possible that one skim milk could be more palatable than another; but the reason is not far to seek: mechanical action in the separator thoroughly aërates the skim milk while it is fresh and has lost none of the aroma peculiar to new milk. Milk exposed to the action of air for twelve or eighteen hours in open vessels loses its aroma, and is apt to become contaminated by an impure atmosphere.

Here we have the other constituents of skim milk separated, by which you will see that we have a very small increase in the proportions of sugar, caseine, and salts, due to the proportion of fat that has been removed.

Our next array of samples shows us a further subdivision. Here we have the cream divided into its two constituents of butter and butter milk. Still the same rule holds good of the constituents of the original milk passing through, though in diminished proportions, into the finished product. Thus butter always contains milk, sugar, and caseine or curd, and even soluble albumen is not entirely

washed away with the butter milk. Still the butter milk, as we see by the central bottle, retains fat, true butter fat, which of course represents so much waste in the process of butter-making.

Taking the other side of our case, where the skim milk heads the column, we have skim milk divided up into cheese and whey. The cheese is represented here by the proportions shown. One of these types is skim milk cheese, with its very small proportion of fat. These cheeses are common enough, and are usually consumed in this country, but there are many cases in which the use of whole milk cheese containing a large proportion of fat is desirable rather than cheeses containing so little fat.

The proportion of fat contained in these cheeses vary, from skim milk cheeses occasionally to be met with containing as little as three per cent. of fat, up to cream cheeses in which the proportion of fat is largely in excess of the proportion of caseine.

Now every one of these constituents we derive from pure milk is capable of being adulterated. There are one or two of these adulterations to which it is necessary I should refer. The most serious portion of adulteration unquestionably is the admixture of butter with foreign fats, and the substitution of inferior fats for the true butter present in cheese.

We will take the latter first. A large number of cheese consumers desire a cheese containing a considerable proportion of fatty matter. This fatty matter of course ought to be the butter natural to milk, but butter is far more valuable than oleomargarine, and therefore extensive manufactories have been established for the production of oleomargarine cheese. This cheese is made of skim milk, skimmed by separators, so that the butter is practically all abstracted, the deficiency of fat being replaced by the addition of oleomargarine or lard, in sufficient quantity to make the cheese a tolerably fat one. I look upon this as an exceedingly flagrant adulteration ; the more so because it is one which is hardly likely to be detected by the consumer. There is no difficulty in detecting the fraud by an analytical

process. The very worst adulteration in the products is of course the use of oleomargarine to mix with or substitute for pure butter. I have nothing to say personally against the use of good carefully made oleomargarine as a substitute for butter, if only it is sold under its own name and at a fair price, but I have the greatest objection to its substitution for butter, which is more valuable and a more digestible diet, and unquestionably more suitable for domestic use. Good oleomargarine is nothing but the very best of beef fat carefully refined and carefully churned with milk, and as such no one can dispute its suitability for use as food; bad oleomargarine, on the other hand, is a compound of vile refuse fats, clarified and refined in any way that will chemically fulfil the object in view; but, to say the least, such a mode of preparing refuse materials for food use is objectionable, and the sale of the inferior sample should be in every way discountenanced.

I want to point out next the means which are available for ascertaining whether any given sample of milk is pure or not. In some respects this problem is comparatively a simple one, but in other respects it presents great difficulty. At the outset we meet with this difficult feature, that milk is a perishable article, and must be consumed within, at the most, a few hours of the time it was obtained from the cow. It follows from this, that it is not practicable for each sample of milk, or, for the matter of that, not one out of one hundred, to be subjected to chemical analysis before its distribution to the consumer; it is obvious, therefore, that some readier and more rapid test must be used or the milk must be sold without any test at all.

A good many different kinds of tests have been proposed for this purpose, and various instruments, under the name of galactoscope and other similar names, have been suggested, by which the degree of opacity of the milk could be read off according to scale, the idea of the inventors being, that the poorer the milk, the fewer would be the number of fat globules contained in it, and therefore the less the opacity of the milk. In practice these instruments signally failed,

in consequence of the fat being the most variable constituent in milk, and also from the fact that the opacity of the fat globules vary considerably.

The microscope has also been suggested as a ready means of detecting adulteration, but except in highly skilled hands this is even less useful, and may now be considered as obsolete as the other. For one thing, however, the microscope still retains and must retain its position : it is practically the only means by which diseased milk, that is milk obtained from diseased cows, can be detected.

One instrument however has survived, and is in constant use by many milkmen : this is the Hydrometer, or as it is more familiarly called in the trade, the Lactometer. This is a valuable instrument in its way, but the results obtained by its use are apt to be misleading, as it simply gives the relative weight of milk compared with water. One gallon of water weighs 10 pounds ; one gallon of milk about 10·3 pounds ; it follows from this that if the milk be admixed with water, the weight of one gallon would be reduced, so that supposing the mixture consisted of half milk and half water, the weight would be 10·15 pounds. Unfortunately, however, the weight of pure milk is not uniform ; it ranges between the rather wide limits of 10·28 and 10·35. We therefore get a possible error introduced at the starting point, and this starting point or zero being erroneous, it follows that all calculations based upon it must be likewise liable to error. If, however, this were all, the instrument would still be a very useful one in the hands of a careful man, but experiments will soon show that there is another great drawback. If a sample of milk with a specific gravity of 10·30 be taken, and the cream carefully skimmed off, the specific gravity of the skimmed milk would be increased by the removal of the butter fat, which is lighter than water, so that the weight of the skimmed milk itself may be as much as 10·34 or 10·36 pounds. It will be seen from this that we have two different ways in which the milk can be tampered with,

viz.: watering, which will reduce the weight of a gallon; skimming, which will increase the weight of a gallon. Both of these processes are profitable to the milk seller, and a moment's consideration will show that if the milk is carefully skimmed and afterwards watered, the original gravity of the milk will be reproduced so exactly as to deceive any person using the lactometer as a test. It is in this way that a good deal of the watered and skimmed milk is passed off by country dealers to the London vendors and by London vendors to their customers. In one case, however, the lactometer is serviceable, and that is to show that the milk coming from any farm keeps day by day a fairly uniform regularity in quality, and that the milk returned by the milk carriers at the conclusion of their rounds comes back in the same condition as when it went out.

The only reliable and trustworthy method of ascertaining the quality of milk, is by means of a full chemical analysis. To carry this out the water contained in the milk is evaporated; the whole of the solid matters of which I have shown you specimens are left behind in a state in which they can be weighed; the fat contained in these solid matters is then extracted by means of either petroleum or some other suitable liquid, and the solids not fat which are left behind are dried again and weighed. These solids not fat form the real standard by which the question of watering is determined; while the fat which has been extracted when weighed forms the real guide as to whether the milk has been skimmed. If either of these two figures were perfectly constant, one problem of milk analysis would be solved, but unfortunately there is a considerable variation in different samples of milk.

To get over this difficulty a low or minimum figure has been adopted as the standard, so as to allow an ample margin for the natural irregularity of composition. Milk dealers are aware of this difficulty in fixing a standard, and are constantly endeavouring to prove that adulterated milk is really pure milk. There is practically no

milk adulteration case ever brought into court in which any other defence is raised. The allowance is always said to be insufficient, and the unfortunate milkman has cows worse in quality than those which have been tested by the analysts, and consequently he obtains milk poorer in quality and worse in character than any which they have seen. This argument, however, has pretty nearly spent itself; it is only occasionally that there is any magistrate who is found to listen to it.

In conclusion, it will be interesting to notice the extent to which pure milk is sold in London. The returns which are made under the Adulteration Acts specify the percentage of adulteration found in each sample, while the tabulated reports issued in the blue books state only the number of adulterated samples, and taking the case of milk do not give the percentage of skimming or watering. This of course seriously diminishes the value of the returns. It is therefore surprising to find that only on one occasion during the last seven years has the percentage of adulterated samples of milk fallen below 20. Out of every 100 samples of milk purchased by the inspectors 20·35 were adulterated, even on the lenient limit of calculation used. But by looking to London alone you will get a better illustration still. At some considerable trouble I have endeavoured to find out what the quality of the average milk supply of London really is. Londoners within the area of the London water companies, supplies number nearly, or quite, four-and-three-quarter millions, say 4,760,000, and the cost of the milk supply is therefore a tolerably large figure.

The limit of pure milk has by almost (but not quite) universal consent been fixed at 9·00 per cent. solids (not fat) and 2·50 per cent. fat. My opinion is that this is if anything too low, especially in fat; so I procured 55 samples during the month of October from entire dairies of milk as the milk arrived in London. The farmers' men may have added a little water, but, unless in one case, I have no reason to think that this has been done. No

precautions whatever were taken to procure special samples, so I am fairly justified in saying that this milk is a fair sample of what dairy farmers can supply in London during the month of October. These deliveries are from the milk of about 2000 cows.

Out of this series of 55 samples, the solids (not fat) fell in one case to 8·93 per cent., with 3·14 per cent. of fat, and in the next lowest case to 9·10 solids (not fat); that is 54 out of 55 samples are above the limit, and the one remaining sample has a high proportion of fat; but the average is more important, and this comes to solids (not fat) 9·60, fat 3·46, total solids, 13·06; so that the average of these 2000 cows is at the very least six per cent. above the limits used by the Society, and nearly 40 per cent. higher in fat.

So much for what comes to London: now let us see what is sold in London.

It is proper to expect that *some* of the best milk should be delivered, for however leniently a milk seller may generally look upon watering, we cannot expect that all of them do so.

I purchased 300 samples in London, and three out of the 300 corresponded with the average of the milks sent to London, and one of the 300 was richer than the average; 296 remain to be accounted for, 93 of these pass the limit; they may have been watered, and, in fact, many probably have, but they are just above the limit; 203, or 67·9 per cent., are below the limit, and this represents the amount of sophistication I have actually found. The percentage of added water in these samples varies from 3 per cent., to 61 per cent. Out of the 300 samples no less than 63, or 20 per cent. of the total, are just on the limit line of solids (not fat) and fat in genuine milk. But as soon as this limit line is passed, watering goes on rapidly; 15 per cent. of the samples contain more than 20 and less than 30 per cent. of added water, and 15 per cent. contain more than 30 per cent.; in all 68 per cent. were watered.

The percentage of skimming is almost equally formidable ; here again I have passed all samples above the limit, though it is too low ; but even on this low calculation 19 per cent. were skimmed as well as watered, and more than 7 per cent. were skimmed but not watered.

This tale of sophistication is really serious to the public. Averaging the 300 samples, the result is that 13 per cent. of the fat has been skimmed off, and that the milk has, in addition, been watered nearly 13 per cent. ; while if the figures I actually found in the dairies are taken as the standard, as I consider they ought to be, 20 per cent. of the fat has been skimmed off, and the watering is 19 per cent.

Ten years' working of the anti-Adulteration Acts has brought us really to this point, that as regards milk our position is hopeless until the law is amended ; no one can hope to get pure milk in London, unless under other guarantees than this Act affords, and we ought to tell the public so, that they may take action in the matter.

Trivial fines of a few shillings do not bear on the question at all. The average consumption of milk in the middle class districts of London may be taken at something like ten gallons per head per year, but to put it at the least I will take $3\frac{1}{2}$ gallons per head per year as the average, or say $1\frac{1}{2}$ oz. per day each person. The milk bill of this population of four-and-three-quarter millions must therefore be, at fivepence per quart, somewhat about £1,400,000, or seven-eighths of the water rates, which are £1,562,000.

This milk appears to be watered on the average nearly 19 per cent. The value of this milk replaced by water is £266,000 per year. It is not easy to say absolutely what value shall be given to the fat, but certainly it is putting the most lenient view possible on the matter if we consider that the abstraction of this fat is equal to a value of £90,000 more.

Adding this figure to the other, I find that we in London pay £356,000 a year for fraudulent dealing with milk—just about one-fifth part of our water rates. How long this will

be tolerated I cannot say, but it needs no calculation to show that the amount is enough to pay a profit to all the vendors concerned, if only it were fairly divided.

After this statement of what is actually being done at the present time in reference to the sale of impure milk, it will surprise no one if I say that I think further legislation is imperatively needed, not only to enforce the adoption of a somewhat more rigid standard, but to increase the efficiency of the supervision at present exercised over the milk supply; a very much larger number of samples should be examined, so that purchasers may procure something like a genuine article instead of an adulterated one.

I am not at all prepared to say that this will not be attended with an increased price in milk; but that I look upon as a matter of trifling moment only, if the steps that are taken are such as to ensure an uniform and genuine article.

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